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이동 백홀 망에서 Radio Access Network의 성능

Performance for Radio Access Network in mobile backhaul network

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요 약 이동 백홀 망에서 RAN은 이동통신 기지국을 이동 백홀망에 연결시켜 준다. 이 시스템은 여러 세대의 이동통신 기술에 따른 인터페이스, 즉 셀 사이트 영역에서는 TDM, ATM, 그리고 이더넷, 이동 백홀 영역에서는 이더넷 인터페이스로 구성된다. 조만간에 TDM 기반의 이동통신 네트워크는 모두 IP/Ethernet으로 전환될 것이고, 궁극적으로 이더넷 및 TDM 트래픽이 IP 네트워크를 통하여 전달될 것 이다. 따라서 이들 기술들을 이동 백홀 망으로 전송되기 위하여 각각은 캡슐화가 되어야 한다. 본 논문에서는 각각의 캡슐화, 즉, ATM, MPLS, IP/UDP, 그리고 MEF8에 따른 성능이 측정되었다.

Abstract RAN in mobile backhaul network connects base station to mobile backhaul network. This the interfaces for several generations mobile communication technologies, such as TDM, ATM, and Ethernet in cell site, and then Ethernet in mobile backhaul site. In near future, the mobile communication network will be changed to all IP/Ethernet one, and then ultimately Ethernet and TDM traffics will be transferred through IP network. So these technologies have to be encapsulated for transferring to the mobile backhaul network. The performances are measured for each encapsulation, such as ATM, MPLS, IP/UDP, and MEF8.

Key Words : backhaul, RAN, MEF, PWE, Emulation

Ⅰ. Introduction

These days as the convergence network of both wired and wireless has been appeared, ISP can provide users with the convenient and cheap communication services. The convergence network is not only meant to convergence both wireless and wired networks in one network, but it also includes the diverse connection interfaces based on all-IP network and can transfer the diverse applications through the network[2][3][5].

The fast growing packet traffics through the mobile communication network has promoted to evolve the existing network to the convergence network based on all-IP. As 3G and 4G data services are introduced, and the data traffics have exceeded the voice traffics, the bottleneck phenomenon is occurred in mobile backhaul

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network[4][5].

As mobile backhaul network connects the mobile communication base stations to BSC/RNC, it has to transfer the bandwidth requirements of the diverse generation technologies, such as 2G, 3G, 4G, and WiMAX. So mobile backhaul network has migrated from TDM/ATM network to all-IP based one via the hybrid of both technologies[2][3].

As RAN(Radio Access Network) system connects the mobile communication base stations to the backhaul network through T1/E1, Ethernet, and ATM interface in cell site, it can reduce the costs of transport link between BS and BSC/RNC. This also can reduce the number of transport links by sharing the transport links that each generation technology uses individually.

New technologies, such as Wi-Fi, WiMAX, and LTE are natively based on packet switched backhaul network, the pseudowire framework is need to transport the existing services, such as TDM over a packet switched network, such as Ethernet, IP, and MPLS. In this paper, the performance of RAN system, such as the processing performance, delay time for ATM, IP, MPLS, and MEF are measured.

Ⅱ. Mobile backhaul network technologies

Figure 1 shows the overall configuration of mobile backhaul network. The mobile backhaul network is the area from the transmission equipment connecting cell sites to the transport aggregation equipment connecting the central sites. So it can be classified into three sections, such as cell site, backhaul network, and mobile core network. To accommodate the growing diverse applications in mobile backhaul network, it has to be changed from TDM/ATM to packet based networks[1][2][4].

This architecture is based on all-packet backhaul network. So to support 2G/3G services, this network has to support TDM/ATM emulation service. To support it on packet-based network, it is important to support QoS similar to TDM/ATM, such as the clock recovery, packet-loss recovery, and real-time mechanisms[2][3].

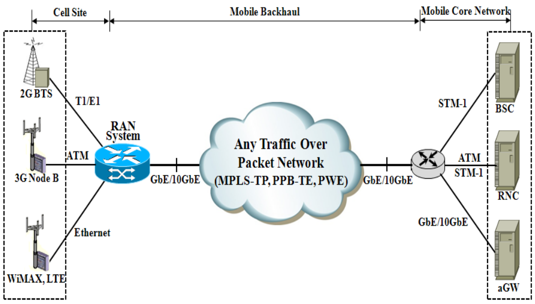

Fig 1. Mobile Backhaul Network
그림 1. 이동 백홀 네트워크

The increase in access and edge network transport is forcing service providers to consider other cost effective transport mechanisms. Circuit switched transport mechanisms, such as E1/T1/E3/T3 and SDH/SONET, has been the core of the voice network. With the evolution of ubiquitous packet networks, there are efforts to transport voice over the packet switched network. Circuit emulation Services over packet networks transport digital trunks such as E1/T1/E3/T3 as well as SDH/SONET circuits over packet networks. There are challenges in realizing virtual circuits over packet networks, with interfaces satisfying the same performance characteristics as the circuit switched networks[7][8].

Ⅲ. RAN architecture

Figure 2 shows RAN system architecture. RAN system can transfer the traffics through IP/MPLS transport network, and the traffics of BS also can be transferred using point-to-point wireless transport technology (wireless bridge). And it provides QoS which can the priority according to the traffic characteristics. Also it connects BS to mobile backhaul network through T1/E1, Ethernet, and ATM interfaces in cell site[6][7].

This RAN system consists of classification, QoS unctions, PWE3, such as payload encapsulation and PSN&physical header. TDM data, which is sensitive to transmission delay time, is transferred through CES in mobile backhaul network. And the rest of data traffics can be transferred through ATM or Ethernet.

SAToP(RFC4553) is suitable for transferring the overall TDM stream without considering framing and DS0 time slots. In the case of TDM stream, RAN ssystem converts the received data stream into the packet of 256 bytes, and inserts SAToP packet header in this packet, and then transfers this packet stream through network. As this provides the simple capsulation service and needs just a few of the general connection items, the installation of SAToP link and the service turn-up are not complicated[8][9]. CESoPSN(RFC5086)는 provides more bandwidth efficiency than SAToP, and user can choose which time slots (64kbps channel or DS0 channel) they transfer trough PSN. As this is efficient in the bandwidth limited access network, this is reasonable in terms of economy. In RAN, for identifying these DS_0, TDM framing function is needed to find the frame alignment signal and the individual time slot[8][10].

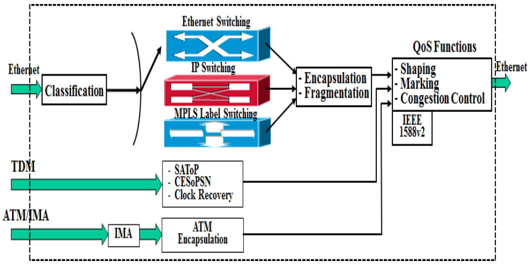

Fig 2. RAN System architecture
그림 2. RAN 구조

TDM signals force TDM traffics to segment, adapt, and encapsulate at PSN input side. At PSN output side, the reverse operation is done. The adaption is the mechanism that has the payload change to do the proper reconstruction at PSN output side. By using the proper adaption method, TDM signal and timing can reconstruct, and the packet loss can be permitted to a certain extent. The capsulation function arranges the adapted payload into the packet type that required and then generated by PSN technology.

Ⅳ. RAN system model and performance

Figure 3 shows RAN system model for measurement. it is connected to cell site through T1/E1, or Ethernet, or ATM&IMA interface. And it also is connected to the backhaul network through Ethernet interface.

if mobile base station is connected to the backhaul network, data rate is more increasing, but the cost of connecting Ethernet of gigabit level is more decreasing. So in the case of installing new backhaul network, IP/Ethernet is selected. But ISPs have to pay high TDM rent costs to maintain hundred thousand BSs which are installed using TDM connections, such as E1, T1, T3, and E3. In fact, the revenue of the existing ISPs is increasing because of the growing number of network for mobile backhaul. So the existing ISPs have adopted the circuit emulation service to change the core network from TDM circuit to the packet based infrastructure while maintaining their own revenue. Therefore, they can decrease the cost by transferring the signals through the cheaper Ethernet network based on this[4][5][7].

Classifier classifies the input traffics from input interfaces, such as TDM, ATM&IMA, and Ethernet, and then stores the classified traffics in the several queues, such as flow based queue, class based one, and VC based one. In ATM interface, the packets are stored in queue according to VC. In the case of Ethernet, Frame relay, and HDLC/PPP, the frames are stored in queue according to flow. In Gigabit Ethernet and high speed POS interface, the packets are stored in queue according to class, and this packet is serviced through the strict priority scheme.

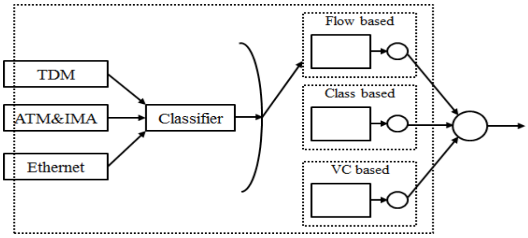

Fig 3. RAN System Model
그림 3. RAN 시스템 모델

Many standards were recently published by IETF PWE3 (Pseudowire Emulation Edge to Edge). PWE3 is the layer 2 VPN that provides the tunnel to emulate the diverse services over PSN(IP, MPLS). In IP/UDP, the encapsulation overheads consists of 14bytes Ethernet header, 20bytes IP header, and 8bytes UDP header. For MPLS, the encapsulation overheads consists of 14bytes Ethernet header, 4bytes MPLS outer label, and 4bytes MPLS inner label. For MEF E-Line, the encapsulation overheads consists of 14bytes Ethernet header, 4bytes outer VLAN tag, and 4bytes inner VLAN tag. In all cases, TDM signals begin with PSN header (IP/UDP&MPLS). These architectures are the standard header applied to PSN technology[1][2][3].

Fig 4 shows the processing performance of RAN system, which is the results in no encapsulation state. The whole link bandwidth is 1Gbps, and the throughput is gained according to the packet length with changing the load by 10%, 50%, 90% for this bandwidth.

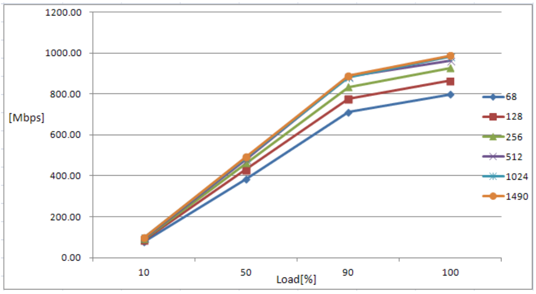

Fig 4. Processing Performance
그림 4. 처리 성능

Fig 5 shows ATM cell delay in RAN system. This delay is the time when one ATM cell is loaded on Ethernet frame. The load is the using one of total 1Gbps bandwidths. This delay is gained according to encapsulations, such as IP/UDP, MPLS, and MEF E-line. In this result, MEF-line encapsulation has larger delay than the remaining two ones.

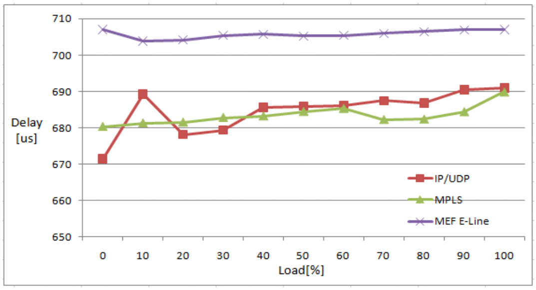

Fig 5. ATM Delay Time
그림 5. ATM 지연 시간

Fig 6 shows the delay of IP packet encapsulated by IP/UDP. The overheads for encapsulation are Ethernet head of 14bytes, IP header of 20bytes, and UDP header of 8bytes. In the case of 64bytes packet, the delay is increased at 90%~100%load. This may be related to the decrease of throughput in this area.

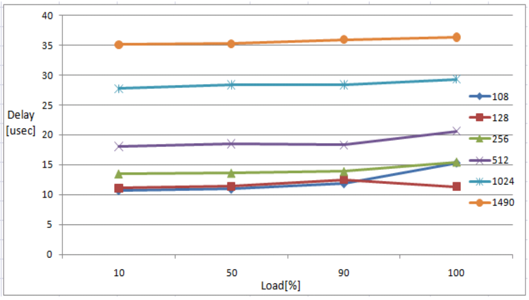

Fig 6. IP delay for IP/UDP
그림 6. IP/UDP에 대한 지연시간

Fig 7 shows the delay of IP packet encapsulated by MPLS. The overheads for encapsulation are Ethernet head of 14bytes, MPLS outer label of 4bytes, and MPLS inner label of 4bytes. The shows the similar characteristics to IP delay.

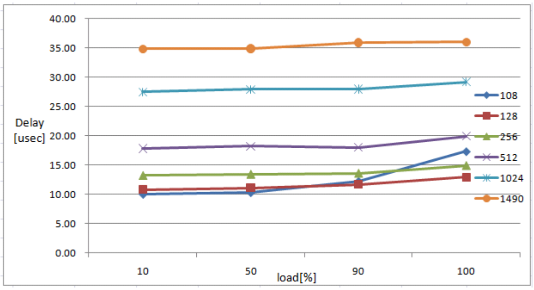

Fig 7. IP delay for MPLS
그림 7. MPLS에 대한 IP 지연시간

Fig 8 shows the delay of IP packet encapsulated by MEF E-line. The overheads for encapsulation are Ethernet head of 14bytes, outer VLAN tag of 4bytes, and inner VLAN tag of 4bytes.

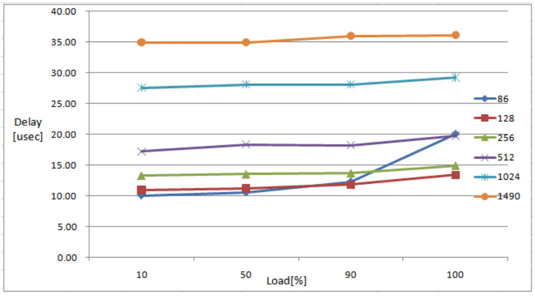

Fig 8. IP delay for MEF
그림 8. MEF에 대한 IP 지연시간

V. Conclusion

The mobile backhaul network has migrated from TDM/ATM network to all-IP based one via the hybrid of both technologies. So it should accommodate all kind of mobile generation technologies. To support RAN backhaul network based on All-IP, it has to consider the diverse requirements, such as clock synchronization, security, Quality of Service, and OAM. This paper addresses the performance of RAN based on PSN with the encapsulation of each interface, such as ATM, IP.UDP, MPLS, and MEF. In the near future, the study for mobile backhaul LTE will be done.

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